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10 Oriented elastomeric film and method of manufacture.

11 An oriented thermoplastic elastomer comprising an elastomer, EVA, and process oil is prepared by stretch orienting the film at an elevated temperature and annealing the film to reduce stresses and strains in the film. In one embodiment, the thermoplastic elastomer is provided with a thin coating of a thermoplastic to provide nonblocking.

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1 Oriented Elastomeric Film and Method of Manufacture

2 This invention relates generally to the thermoplastic elastomers and in particular, to the thermoplastic elastomers which have been thermally oriented.

5 Thermoplastic elastomers possess properties of both thermoplastics and elastomers and have a wide range of applications. In certain applications, a thermoplastic elastomer film is dimensionally stabilized in a stretched condition (wherein stresses and strains in the film have been frozen in) for subsequent use. For example, the 10 stretched thermoplastic elastomer may be applied to a substrate and later heated causing the thermoplastic elastomer to shrink and retain 11 substantial elastic properties. One such use is disclosed in European 13 Patent Application No. 84301717.9 (Publication Number 0119627) wherein 14 the stretched dimensionally stable thermoplastic elastomer is placed 15 on a diaper waistband and reheated causing the thermoplastic elastomer 16 to contract and revert to a heat stable elastic state. The diaper 17 thus, is provided with a flexible and stretchable waistband. A 18 similar application of thermoplastic elastomers is disclosed in European Patent Application No. 84301720.38 (Publication Number 19 0119627). These publications are cited merely to disclose a possible 20 use of thermoplastic elastomers.

22 In many applications, particularly where the thermoplastic elastomer is secured to a substrate for later contraction by the 23 application of heat, it is important that the thermoplastic elastomer 24 have relatively high shrink force since the substrate resists shrinkage. The shrink force is determined by measuring the shrinkage of the 27 film sample against an applied force and is referred to herein as 28 weighted shrink. The weighted shrink properties differ markedly from 29 free shrinkage (no applied weight) and hence is a key property in 30 determining the suitability of a heat shrinkable film on substrates.

31 U.S. Patent 4,303,571, issued to D. S. Jansen et al disclose 32 a thermoplastic elastomer film comprising 25 to 55 parts by weight of 33 an ethylene-propylene copolymer, 35 to 55 parts by weight of an EVA 34 copolymer and 15 to 25 parts by weight of a liquid hydrocarbon precipitated 35 oil.

1 As will be demonstrated in the discussion of the
2 examples contained herein, the elastomeric film of the
3 invention disclosed in U.S. Patent No. 4,303,571 has very
4 shrink properties, but not nearly as good as those of the
5 composition of the present invention, particularly the
6 weighted shrink properties.

7 A problem associated with thermoplastic elastomers is the
8 stiffness which impedes unwinding of the film during processing. This is a
9 particularly serious problem with film compositions containing a large
10 processing oil. Moreover, addition of particular additives is not
11 particularly effective in thermoplastic elastomers because of the
12 difficulty in dispersing the additives uniformly in the film structure
13 since the additives tend to concentrate in the elastomer phase.

14 SUMMARY OF THE INVENTION

15 The present invention provides an improved film composition
16 and process for manufacturing which exhibits excellent shrink force
17 and possesses nonblocking properties.

18 The film composition in one embodiment of the present invention
19 comprises from 10 to 40 weight percent of an olefinic elastomer,
20 not more than 12 weight percent (preferably not more than 10 weight
21 percent) of a normal liquid processing oil, and from 50 to 80 weight
22 percent of a thermoplastic ethylene copolymer, preferably vinyl ac-
23 etate copolymer (EVA), all weight percents based on the weight of the
24 three component composition. The film is dimensionally stable in a
25 stretched condition (draw ratio of 1.3:1 to 6:1) and is contractible
26 to a thermally stable and elastic condition by the application of
27 heat.

28 The method for preparing the thermoplastic elastomer film
29 comprises stretching the film at a temperature below the melting point
30 of the EVA component at a draw ratio between about 1.3:1 and 6:1,
31 annealing the stretched film, and cooling of the film to ambient
32 temperature. The film may be used by securing it to a substrate such
33 as a inelastic thermoplastic or fabric, and heating the film to an
34 elevated temperature whereby the film contracts to a dimensionable
35 length and possesses elastic properties. The composite thus may be
36 expanded by the application of tension which upon release returns to
37 its original shape.

1 In another embodiment of the invention, the film comprises
2 composite of one layer of a thermoplastic elastomer and a thin coating
3 of an ethylene polymer or copolymer having a relatively high Melt
4 Index. Upon the subsequent stretch orienting the composite,
5 coating becomes even thinner. The thermoplastic elastomer may
6 preferably the composition as defined above, particularly if
7 shrink force is desired in addition to antiblock properties.
8 coating preferably also contains particulate antiblock additives, thus
9 avoiding the difficult problem of distributing antiblock particles
10 or near the film surface.

11 The present invention contemplates (1) an improved oriented
12 oriented, dimensionally stable thermoplastic elastomer film
13 shrinkable upon application of heat, (2) a composite of a
14 thermoplastic elastomer and a substrate wherein the orientation has been
15 released by the application of heat, (3) a method of preparing the
16 oriented thermoplastic elastomer film, (4)-a method of manufacturing
17 an elastic composite comprising a thermoplastic elastomer and a sub-
18 strate of inelastic material, (5) a thermoplastic elastomer having
19 a thin coating of a nonblocking polymer and (6) a method of preparing a
20 nonblocking thermoplastic elastomer.

21 DESCRIPTION OF THE PREFERRED EMBODIMENTS

22 In describing the present invention, it is necessary to use
23 certain technical terms, some of which are commonly used in the industry
24 and others of which are defined herein to express a concept.

25 In order to avoid confusion, the following terms used herein
26 shall have the meaning indicated:

27 "Draw ratio" - the ratio of the final stabilized length
28 (after orientation and "snapback") of an oriented film and
29 the initial length of the film before orientation. Draw
30 ratio in unidirectional orientation is also equal to the
31 ratio of the thickness of the stabilized oriented film and
32 the initial unoriented film.

33 "Shrink force" - the force required to prevent shrinking of
34 an oriented film by application of heat.

35 "Shrink stress" - the shrink force in unit area (g/cm²).

36 "Annealing" - a heat treatment process for reducing
37 stresses set up in the film during orientation. The
38 process comprises maintaining the film while in a
39

condition at the annealing temperature, for a time sufficient to anneal the film, followed by cooling the film to room temperature.

"Thermoplastic elastomer" - frequently called "thermoplastic elastomers" or "TPEs" - are blends of a thermoplastic and a thermoset elastomer that are processable as a melt, at elevated temperatures, but exhibit properties similar to vulcanized elastomers at room temperature.

"Melt Index" (MI) - g/10 min (ASTM-D 1318):

In its broadest form, the thermoplastic elastomer composition of the present invention comprises three components, namely, (1) olefinic elastomer, (2) ethylene copolymer, and (3) process oil.

The concentrations of the three components of the blend are as follows:

Component	Concentration	Concentration	Preferred
Olefinic Elastomer	10-40 wt %	15-30 wt %	21-30 wt %
Ethylene Copolymer	50-80 wt %	60-80 wt %	68-75 wt %
Process Oil	0-12 wt %	2-10 wt %	4-8 wt %

The above concentration range may be combined in any permissible combination, although the particular combinations shown are preferred. For example, a preferred composition comprises 10-40 wt % elastomer, 60-80 wt % ethylene copolymer, and 0-12 wt % process oil. The weight concentration of each component is based on the total weight of the three main components.

Elastomer Component: The olefinic elastomer component of the composition preferably comprises an ethylene copolymer elastomer, such as a copolymer of ethylene with higher alpha-olefin. Preferred ethylene elastomer copolymers include EPM (ASTM D-1418-72a designation for an ethylene-propylene elastomer copolymer) or EPDM (ASTM D-1418-72a designation for an ethylene-propylene diene elastomer terpolymer). Also usable are high molecular weight polyisobutylene, butyl rubbers and halogenated butyl rubbers.

Preferred ethylene elastomer copolymers for use herein comprise from 30 to 90 weight percent ethylene, more preferably from 35 to 80 weight percent ethylene, and most preferably from 50 to 80 weight percent ethylene and have a Mooney viscosity (ML 1+2 at 127° C) between 25 and 80.

1 EPDM is a terpolymer of ethylene, a higher alpha-olefin such
2 as propylene, and a nonconjugated diene. In such elastomers the
3 nonconjugated diolefin may be straight chain, branched chain or cyclic
4 hydrocarbon diolefins having from 6 to 15 carbon atoms.

5 Of the nonconjugated dienes typically used in
6 copolymers, preferred are dicyclopentadiene, 1,4-hexadiene,
7 1,5-hexadiene-2-norbornene and 5-ethylidene-2-norbornene; 5-ethylidene-2-norbornene
8 and 1,4-hexadiene are particularly preferred diolefins. EPDM elastomers and their method of manufacture are well known to those skilled in the art. Oil extended EPDM elastomers may also be used. Preferred EPDM elastomers contain from 30 to 60 weight percent ethylene and most preferably from 50 to 60 weight percent ethylene, and from 0.5 to 15 weight percent of the nonconjugated diene.

14 As mentioned above, the olefinic elastomer useful in this
15 invention may also be a polyisobutylene, a copolymer of isobutylene
16 and isoprene (generally known as butyl rubber) or a halogenated co-
17 polymer of isobutylene and isoprene (generally known as halogenated
18 butyl rubber, such as chlorinated, brominated and chlorobrominated
19 butyl rubber). Butyl rubber is a vulcanizable rubber copolymer con-
20 taining from 85 to 99.5 percent combined isooolefin having from 4 to 8
21 carbon atoms and from 0.5 to 15 percent combined conjugated diolefin
22 having from 4 to 8 carbon atoms. Such copolymers and their prepara-
23 tion are well known, and generally the isooolefin is a compound such as
24 isobutylene and the diolefin is a compound such as butadiene or iso-
25 prene. Halogenated butyl rubbers are also well known: chlorinated
26 and brominated butyl rubber generally contains from 1.0 to 1.6 weight
27 percent bromine and from 0.05 to 0.5 weight percent chlorine.

28 Ethylene Copolymer Component: The ethylene copolymers
29 include those of ethylene and alpha-olefins having 3 to 16 carbon
30 atoms such as propylene or 1-butene. Also included are copolymers of
31 ethylene with unsaturated esters of a lower carboxylic acid or with an
32 unsaturated carboxylic acid. In particular, copolymers of ethylene
33 with vinyl acetate (EVA), or with acrylic acid (EAA), or methacrylic
34 acid (EMA), are preferred. The ethylene copolymers to be used will
35 generally contain from 50 to 99 weight percent ethylene, and more
36 preferably from 60 to 95 weight percent ethylene.

1 The most preferred ethylene copolymer is
2 Ethylene Vinyl Acetate. The EVA may have a vinyl acetate content
3 between about 2% and 40% by weight, with about 10% to 20% by weight
4 VA being preferred.

5 VA contents below about 5 wt % are useful for
6 flexibility and orientability for purposes of this invention.
7 VA contents above 40 wt % exhibit excessive softening
8 balance of orientability and non tackiness is best
9 between 10 and 35 wt %.

10 Preferred Melt Index (ASTM D-1238), MI, is in the range of
11 from 1 to 20, with 2 to 10 being most preferred.

12 The ethylene copolymer component normally has an operating
13 temperature of the tentering and stretching operations.
14 These operations may be carried out at temperatures of about 71°C
15 and below (preferably not more than 5.6°C above the crystalline
16 melting point of the ethylene copolymer component). The stretching
17 preferably is at $\pm 11.1^\circ\text{C}$ of the orienting temperature. The crystalline
18 melting point of EVA ranges from approximately 40°C to 50°C,
19 depending on the VA content and MI, with the preferred MI's having
20 crystalline melting points between about 55°C and 70°C.
21 For economics, orienting temperatures of 71°C and below are preferred.

22 Process Oil Component: Hydrocarbon oils useful in the
23 present invention function as process aids whose activity is enhanced
24 in the presence of vinyl acetate copolymers, as plasticizers producing
25 low modulus and enhanced elasticity in the solid state and those
26 useful are the normally liquid hydrocarbon processing and extender
27 oils (ASTM D 2226) categorized as aromatic, highly aromatic, naph-
28 thenic and paraffinic process oils of a medium viscosity range. Oils
29 sold under the trademarks "Flexon" and "Suppar" have been found
30 especially useful.

31 Other Additives: The composition may also include a filler
32 material, an antiblock agent, processing aids, stabilizers and other
33 conventional additives.

34 FILM PREPARATION

35 Resin/Blend Preparation: Preparation of composition, usable
36 in this invention can be achieved in several different ways. The
37 various components may be brought into intimate contact as, for example,
38 dry blending these materials and then pressing them into a film.

1 composition through a compounding extruder. Alternatively, the 2 components may be fed directly to a mixing device such as a compounding 3 extruder, high shear continuous mixer, two roll mill or an inter- 4 mixer such as a Banbury mixer. The optional ingredients 5 described can be added to the composition during this mixing 6 operation. Overall, the objective is to obtain a uniform dispersion of 7 ingredients and this is readily achieved by inducing sufficient 8 and heat to cause the plastics component(s) to melt. However, 9 the temperature of mixing should be controlled as is normally done by 10 one skilled in the art so as to avoid molecular weight degradation.

11 Film Extrusion: Film from the resin compound may be manufactured 12 by conventional tubular extrusion, (blown bubble process) or by 13 cast extrusion, with the latter being preferred. In the cast extrusion 14 process, the molten resin is extruded from an elongated die in the 15 form of a web. The web is cast onto a chill roller, which solidifies 16 the polymer, and finally wound into a roll.

17 The extrusion temperatures, die temperatures, and chill roll 18 temperatures will depend on the composition employed, but generally 19 will be in the following ranges for the compositions of the present 20 invention prepared by cast extrusion:

Melt Temperature (°F)	350-450	(°C) 175-230
Die Temperature (°F)	350-450	(°C) 175-230
Chill Roll Temperature (°F)	70-130	(°C) 21-50

21 The process described above may also include a set of embossing rolls 22 to chill and form the film.

23 Orientation: Orientation of the film may be carried out in 24 the machine direction (MD) or the transverse direction (TU) or both 25 directions (biaxially) using conventional equipment and processes.

26 For orientation in the MD, a polymeric film 27 is heated to a 28 temperature (but below the crystalline melting point of the polymer) 29 and is passed from a feed roll of film around two rollers with different 30 different surface speeds and finally to a takeup roller. The driven 31 roller closest to the takeup roller is driven faster than the driven 32 roller closest to the feed roll, such that the film is stretched 33 between the driven rollers. The assembly may include a roller intermediate 34 the second roller and takeup roller to cool the film. The 35 second roller and the takeup roller may be driven at the same speeds. 36

1 peripheral speeds to maintain the film in the stretching area. 2 If supplementary cooling is not used, the film will tend to reach 3 temperature on the take up roll.

4 The degree of stretch will depend upon the ratio of peripheral 5 speeds of the driven rollers and the distance between the 6 rollers. Stretch rates of 50 to 500 percent/minute will be satisfactory 7 for most MD orientation applications.

8 Preferably, however, film orientation will be carried out in 9 a tentering device to impart TD orientation to the film. The film is 10 cast as described above or is unwound from a film roll and then 11 gripped by the edges for processing through the orientation steps. 12 The film is passed successively through a preheat step, a stretching 13 step at elevated temperatures (e.g. from 37.7° C. to a temperature 14 slightly below the crystalline melting point of the ethylene 15 copolymer), an annealing step, and finally a cooling step. (Although 16 cooling may be considered part of the annealing step, for convenience 17 it is described as a separate step herein.) The preheat, orientation, 18 and a portion of the annealing temperature is controlled at an 19 elevated temperature but below the crystalline melting point of the 20 polymer. Although not essential, it is preferred that tension be 21 maintained on the film during the annealing and cooling steps to 22 minimize shrinkback. Upon cooling to ambient temperature (i.e., room 23 temperature) or near ambient, the holding force may be released. The 24 film may contract somewhat (snapback) in the TD but will retain 25 substantial portion of its stretched length.

26 The tenter operating conditions can vary within relatively 27 wide ranges and will depend on the several variables including film 28 composition, film thickness, degree of orientation desired, annealing 29 conditions, etc. The following is exemplary of a process for stretching 30 100 micron thick film (containing EVA) from 61 cm wide to a 31 final width of about 152 cm, using a tenter manufactured by 32 Marshall and Williams Company of Providence, Rhode Island.

ESTIMATED FILM RANGE

Step	Broad	Preferred	Typical
4 Preheat	100-160°F 37.7-71°C	115-140°F 46-60°C	125°F 51.6°C
5 Stretching	100-160°F 37.7-71°C	115-140°F 46-60°C	125°F 51.6°C
6 Annealing	100-160°F 37.7-71°C	110-150°F 43-66°C	120°F 54.4°C
7 Cooling	Ambient	Ambient	Ambient

As indicated earlier, it is highly desirable to employ an annealing step in the process. Annealing partially relieves the internal stress in the stretched film and dimensionally stabilizes the film for storage. It has been found that by annealing the film at a temperature of $\pm 22.2^{\circ}\text{C}$, preferably $\pm 11.1^{\circ}\text{C}$ of the orientation temperature (but slightly below the crystalline melting point of the ethylene copolymer) eliminates undesirable shrinkage during storage. The preferred annealing temperature is between 110°F and 130°F. Temperatures which result in excessive stress relieving should be avoided, since substantial frozen in stresses and strains should remain after the process is completed.

Annealing can be accomplished by maintaining the film in the stretched condition at the annealing temperature. Preferably, however, the annealing and cooling is carried out while permitting the film to contract slightly, but still under stress. The guide rails of the tenter can be arranged in a converging manner to provide the annealing and cooling while the film contracts. The controlled shrink-back of from 5 to 30%, preferably between 15 and 25% of the maximum stretched width has given particularly good results in eliminating storage shrinkage. This annealing and preshrinking removes some of the film stresses and strains so that shrinkage will not occur at storage temperature. However, the annealing and cooling fails to remove all the frozen in stress and strain, since upon heating to elevated temperatures above storage temperature the film will shrink.

The degree of stretching may vary within wide limits. Draw ratios of 1.3:1 to 6:1 are possible with 2:1 to 4:1 being preferred for TD tentering. The actual stretching will occur at higher ratios (1:5 to 9:1) to allow for controlled shrinkage and snapback.

EXAMPLES

In order to demonstrate the effectiveness of the present invention, particularly in respect of improved shrink force and non-blocking properties, a series of experiments were conducted to test the performance of the film of the present invention with the prior art (U.S. Patent No. 4,303,571).

Film Samples:

Samples having the compositions listed in Tab. I were prepared by blending the components in the weight ratios indicated using a Banbury mixer. Each composition also included 6 wt % ethylene acrylic acid copolymer and filler material (CaCO₃). The resin blend was cast extruded into 150 micron (approx.) thick film using 7.6 cm extruder and 76.2 cm wide flat die.

Properties of the Film:

Each film sample was then tested for orientation/shrinkage properties with an Instron (Model 1122) in a temperature controlled chamber. 2.5 cm wide strips (cut in the TD) were taken from each sample, marked with lines 4 cm apart and then drawn to 9 cm at 10 cm/minute at an elevated temperature (60°C and 63°C). After orientation, each stretched film was quenched with water and removed from the Instron. Six film strips were drawn for each formulation and the test was run in random order in blocks of nine to eliminate systematic test error.

For each formulation, 6 strips were heated in the oven for three minutes at 65.5°C; three strips with a fixed weight and the other three strips freely suspended. The film strips were removed from the oven, allowed to cool and then measured to determine the % recovery.

The % recovery was calculated by the following formula:

$$\text{Percent Recovery} = \frac{\text{Initial length}^* - \text{Final length}^{**}}{\text{Initial length}^*} \times 100$$

* Initial stretched length (cm) after "snapback".

** Final length (cm) after full shrinkage at 150°F in oven.

Table II presents the results, comparing the three sample average for each formulation of the present invention (Samples A, B and C) with the three sample average of each formulation of the prior art (Samples D, E and F).

1 As revealed in Table II, the percent recovery under re-
2 strained conditions Samples A, B and C was higher than that of Samples
3 D, E, and F. Percent restrained recovery for the A, B, C sample group
4 averaged 85.4%, whereas that of D, E, F group averaged 81.8%. The
5 shrink force, which is the force required to keep the film from
6 shrinking can be calculated from these data. As will be shown,
7 the shrink force for Samples A, B and C was substantially higher
8 than that for Samples D, E, and F. Samples A and B exhibited particularly
9 improved shrink force.

10 The higher shrink force of the Samples A, B and C permits use
11 of a thinner gauge film at the same draw ratio as demonstrated by the
12 following experiments.

13 Additional experiments were conducted to determine the shrink-
14 age as a function of restraining force and shrinkage temperature. Two
15 oriented films having the compositions of Samples A and B were pre-
16 pared using a Marshall and Williams Tenter operated under typical
17 conditions described in the Orientation section hereof. Each film
18 thus was processed as follows:

	Sample A	Sample B
20 Initial Length	(22.5 inches) 57.15cm	(22.5 inches) 57.15cm
21 Stretch Length	(66 inches) 168cm	(66 inches) 168cm
22 Controlled Shrinkback		
23 Length	(60 inches) 152cm	(50 inches) 130cm
24 Final Stabilized Length	(50 inches) 127cm	50 inches) 127 cm
25 Film Gauge (Initial)	102 microns (avg)	104 microns (avg)
26 Film Gauge (Final)	42 microns (avg)	50 microns (avg)
27 Draw Ratio (Initial Film 28 Gauge/Final Film Gauge)	2.42	2.51

29 Strips (three for each test) of each film sample were cut
30 and subjected to shrinkage in an oven at a controlled temperature
31 (40°C or 65.5°C) and at the following restraining forces: 0, 10, 20, 30,
32 45 g and 60 g. Each strip was permitted to shrink for 10 to 33
33 minutes. Table III presents the three-strip average for each 34
35. These data demonstrate that the shrink stress for the composition 36
37 of the present invention was substantially higher than the compositions 38
39 of the prior art. Moreover, the shrink force for Sample A was

1 exhibited substantially higher shrink force than the Sample A strips,
2 even though the latter strips were substantially thicker (in gauge and
3 hence larger cross sectional area) than the former strips.

4 It is preferred that the thermoplastic elastomer film on the
5 present invention have a shrink stress of at least 5,000 g/cm² at
6 the orientation temperature, thereby providing sufficient shrinkage
7 for its intended purpose. It is also preferred that the shrink force at
8 65.5°C be at least 5,000 g/cm².

9 It is interesting to note from the Table III data that the
10 shrinkage is generally linear with respect to the applied force. This
11 permits calculating the shrink force and shrink stress. Note that the
12 shrink temperature of 65.5°C is higher than the orientation temperature
13 and 49°C is lower than that temperature. The higher temperature
14 results in more shrinkage since more stresses are released.

Antiblock Properties

15 The composition of the present invention also exhibits good
16 antiblocking properties in comparison to films of the compositions of
17 samples D, E and F.

18 Multi-layers of each film Sample A, B, C, D, E and F composi-
19 tions (150 micron thick unoriented) were stored for several weeks.
20 The films were then manually separated and subjectively rated for
21 blocking (i.e., resistance to unwinding).

	<u>Sample</u>	<u>Observed Blocking</u>
24	A	No blocking
25	B	Slight tackiness
26	C	No blocking
27	D	Fully Blocked
28	E	Partial Blocking
29	F	Partial Blocking

30 Antiblock property is important in unwinding the film during
31 tentering or during unwinding the oriented film of use. Sticking of
32 the film is undesirable since it slows down the operation or renders
33 the process inoperable.

THERMOPLASTIC ELASTOMER WITH COATING

34 Another embodiment of the present invention is directed
35 specifically at solving blocking associated with thermoplastic elastomers,
36 particularly those containing process oil and for high VA, acry-
37 lene vinyl acetate. These films are tacky by nature and require

1 antiblock agents such as particulate silica. The elastomer present in
2 these blends appears to prevent uniform distribution of particulate
3 antiblock in the resin with the result that the antiblock does not
4 become uniformly distributed on the film surface.

5 In one aspect of this invention, a thin coating of an ethylene
6 polymer or copolymer is provided on one or both sides of the base
7 thermoplastic elastomer (core). The subsequent stretching of the film
8 further reduces the thickness of the coating. The coating thickness
9 ratio (final/initial) is in proportion to the draw ratio. Preferably
10 the coating comprises conventional low density polyethylenes (LDPE),
11 having a high Melt Index (in excess of 3.0). Other ethylene polymers
12 and copolymers that may be used as the coating include linear
13 density polyethylenes (LLDPE), EVA, etc. These materials should have
14 relatively high Melt Indices (in excess of 3.0, preferably 5.0-30.0)
15 and should be capable of high draw down, making them suitable for
16 coextrusion with the base resin (core layer), and should possess non-
17 tacky properties or be treatable to a nontacky condition (e.g.
18 addition of antiblock). Coextrusion is the preferred coating method,
19 but extrusion coating may also be used.

20 It is essential that the coating be sufficiently thin to
21 avoid interference with the shrink and elastic properties of the
22 thermoplastic elastomer but sufficiently thick to impart antiblock
23 properties to the composite. This latter requirement means that the
24 coating must be capable of carrying uniformly distributed therein
25 particulate finely divided antiblock agent.

26 As applied to the core or base resin, the coating will com-
27 prise between 2 to 15, preferably 2 to 10 weight percent of the com-
28 posite and not more than 25 microns thick. Following the orientation,
29 the coating will be reduced to a thickness of not more than 7 microns
30 and as thin as possible. Preferred thickness after orientation is
31 between 1 and 5 microns.

32 The amount of antiblock in the coating may range from 500 to
33 5,000 ppm, with 1,000 to 4,000 being preferred. The coating may
34 include slip agents such as erucamide and oleamide.

35 The coating may be applied to only one side of the base resin,
36 but preferably is applied to both sides.



1 It should be noted that the invention comprising the coating
2 embodiment is not restricted to the thermoplastic elastomer composition
3 specified in the earlier description of the "Elastomer Component"
4 as the core (although these compositions are the most preferred) but
5 may instead contemplate the use of any thermoplastic elastomer resin
6 composition. The preferred resin composition comprises from 35 to 55
7 wt % of the elastomer component, from 35 to 80 wt % of the
8 component, and from 2 to 25 wt % of the processing oil component.

OPERATION

10 In practice, the process of the present invention may be
11 carried out using an in-line operation wherein the extruder and
12 orientation system (e.g., tenter) are arranged in tandem to form the
13 film by casting or melt embossing followed by orientation.
14 Alternatively, these operations may be carried out separately.

15 In a preferred embodiment, the compounded resin containing
16 the three main ingredients along with the other additives is intro-
17 duced into an extruder and extruded into a web from a flat or slot-
18 hanger type die and melt embossed through counter rotating chill
19 and embossing rolls. The film thickness may vary from 50 to 400
20 microns before orientation and from 10 to 200 microns after
21 orientation. Preferably the film will have a final stabilized thick-
22 ness of between 10 and 100 microns after orientation and annealing.
23 The film is wound on a take up roll and transferred to tentering
24 equipment or processed in line with the tenter.

25 The edges of the film are gripped in the tentering frame
26 and passed successively through (a) a preheat stage, (b) an orientation
27 stage wherein the film is stretched laterally at an elevated tempera-
28 ture, (c) an annealing stage and, finally, (d) a cooling stage wherein
29 the stretched film is cooled to near ambient temperature. Once the
30 restraining force is released, the film snaps back slightly
31 retaining most of its stretched length. This film is wound on
32 a roll, ready for transport or use.

33 The dimensionally stable film may be secured to a
34 substrate and heated causing it to shrink. Shrinkage commences at a
35 few degrees above storage temperature, reaching maximum at some
36 temperature above the orientation temperature.

- 15 -

1 In the embodiment for the coating of a thermoplastic elastomer,
2 the operation may be the same as above except that in extrusion
3 of the resin to form the film, a coextrusion die may be used to apply
4 the thin coating on one or both sides of the thermoplastic elastomer
5 core.

6 In either embodiment, the film produced has excellent tensile
7 force properties and good antiblock properties.

TABLE I

Component	FILM SAMPLE			COMPARATIVE FILM SAMPLES		
	A	B	C	D	E	F
Elastomer ¹	22.6 wt %	27.0 wt %	39.4 wt %	39.4 wt %	22.6 wt %	27.0 wt %
EVA ²	71.7 wt %	66.2 wt %	55.0 wt %	41.6 wt %	50.4 wt %	49.6 wt %
Process 011 ³	5.6 wt %	6.8 wt %	5.6 wt %	19.0 wt %	19.0 wt %	23.4 wt %
MI	3.25	2.63	2.16	2.6f	6.6	10.3

1 Ethylene-propylene copolymer rubber marketed as Vistalon 3708 by Exxon Chemical Company.

2 LD-767 (28 wt % VA) sold by Exxon Chemical Company.

3 Arco Prime 350 sold by Arco Chemical Company.

0201331

TABLE II

<u>Sample</u>	<u>Test</u>	<u>Initial Gauge (microns)</u>	<u>Initial Length (cm)</u>	<u>Final Length (cm)</u>	<u>% Recovery (Actual Draw)</u>	<u>Calculated Shrink Force (grams)</u>
A	Free	157.5	8.0	4.3	91.6	222
	Restrained	149.9	8.0	4.5	87.5	
B	Free	157.5	8.0	4.4	90.0	450
	Restrained	157.5	8.0	4.5	86.8	
C	Free	152.4	8.0	4.4	89.9	169
	Restrained	154.9	7.9	4.6	85.6	
D	Free	152.4	8.1	4.3	91.9	134
	Restrained	149.9	8.2	4.7	82.2	
E	Free	160.0	7.9	4.3	91.5	148
	Restrained	162.6	8.0	4.7	82.6	
F	Free	157.18	8.1	4.4	88.5	127
	Restrained	152.4	8.1	4.7	81.3	

TABLE III

		Strip Length after shrinkage (cm)						Shrink Force (grams)*			Shrink Stress Area (g/cm ²)	
		0	12	24	36	48	60	9.33	91	.010	9.100	
		49° C	8.08	8.33	9.62	8.89	9.08	9.43	73	.011	6.636	
		65.5° C	5.83	6.26	6.98	7.73	8.30	9.43				
		49° C	8.57	8.82	9.15	9.41	9.74	10.01	59	.014	4.214	
		65.5° C	5.73	6.23	6.91	7.90	8.75	10.04	65	.016	4.063	

* three strip sample average

** calculated

Claims

1. An oriented film having a blend composition comprising from 6 to 40 weight percent of an olefinic elastomer, 30 to 60 weight percent of a normally liquid process oil, and from 30 to 40 weight percent of a thermoplastic ethylene copolymer, said film having been stretch oriented in draw ratio of from 1.5:1 and 5:1, the film being thermally stable, thermally unstable in the scratch range, and contractible to a thermally stable and elastic condition on application of heat.
2. A film as defined in claim 1 wherein the thermoplastic ethylene copolymer is EVA, EA1 or EPM, and the film has been stretch oriented in the transverse direction at a temperature not less than 37°C and not more than 5.6°C below the crystalline melting point of the copolymer and partially annealed in stressed condition.
3. A film as defined in claim 3 wherein the blend composition comprises from 15 to 30 weight percent of EPM or EPMI as olefinic elastomer, from 60 to 80 weight percent of EVA having a vinyl acetate content of 9 to 40 weight percent, and from 2 to 10 weight percent of a normally liquid aromatic, naphthenic or paraffinic process oil.
4. A film as defined in claim 3 wherein the composition comprises from 20 to 30 weight percent of the olefinic elastomer, from 65 to 75 weight percent of the EVA, and from 4 to 8 weight percent of the processing oil.
5. A film as defined in any of claims 1 to 4, wherein the film has been stretch oriented in the transverse direction at a draw ratio of from 2:1 to 4:1.

6. A film as defined in any of claims 1 to 5, wherein the film has a shrink stress of at least 5,000 g/cm² at the stretch or orientation temperature.

7. A composite comprising

- (a) a first layer comprising the film of claim 6 or claims 1 to 6; and
- (b) a second layer of stretch oriented film of claim 6 or said first layer and comprising a polymer of a copolymer of ethylene having a Melt Index of between 5 and 30, said second layer being no thicker than 7 microns in the stretched condition and comprising from 2 to 15 weight percent of the copolymer.

8. A composite as defined in claim 7 wherein said second layer is coextruded with said first layer.

9. A composite as defined in claim 7 or claim 8, wherein the second layer comprises LDPE having a Melt Index between 5 and 30.

10. A composite as defined in claim 9 wherein a layer of LDPE is coextruded onto each side of said first layer.

11. An oriented composite comprising

- (a) a layer of a thermoplastic elastomer film containing from 2 to 25 wt % of a process oil; and
- (b) a coating of a polymer or copolymer of ethylene coextruded with said first layer and having a Melt Index of between 5 and 30, said coating being less than 7 microns thick in the oriented condition and containing from 500 to 5,000 ppm of a peroxide antiblock agent.

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12. A process for preparing a heat shrinkable film comprising

- (a) extruding a molten blend comprising
 - (i) from 10 to 40 weight percent of an elastomer;
 - (ii) not more than 30 weight percent of a liquid carbon oil; and
 - (iii) from 50 to 80 weight percent of an ethylene plastic copolymer of ethylene;
- (b) stretch orienting the film in the TD direction by 2 times its original length at a temperature not less than 37°C and not more than 5.6°C below the crystalline melting point of the ethylene copolymer;
- (c) partially annealing the stretched film;
- (d) cooling the film while maintaining a tension in the film.

13. A process as defined in claim 12 wherein the ethylene copolymer is EVA, EAA, or EMA.

14. A process as defined in claim 13 wherein the annealing step is carried out under stress and at a temperature between $\pm 11.1^\circ\text{C}$ of the orienting temperature.

15. A process as defined in claim 14 wherein the annealing and cooling steps are carried out in part by permitting the film to shrink in the TD by no more than 50% of the total stretch distance.

16. A process as defined in any of claims 12 to 15 wherein the stretch orientation stretches the film by from 2 to 4 times its original length in the TD.

17. A process for preparing a heat shrinkable film which comprises

- (a) stretch orienting a film having a thickness of between 50 and 400 microns and a composition of
 - (i) from 15 to 30 weight percent of an EPM or EVA thermoplastic elastomer;
 - (ii) from 60 to 80 weight percent of an ethylene vinyl acetate copolymer (EVA) having a vinyl acetate content of about 15 to 35 weight percent; and
 - (iii) from 2 to 10 weight percent of a normally liquid hydrocarbon process oilby drawing the film in the transverse direction 1.5 to 9 times its original length at a temperature of 37°C to below the crystalline melting point of the EVA;
- (b) partially annealing the film at an annealing temperature of $\pm 22.2^{\circ}\text{C}$ of the stretch temperature but less than the crystalline melting point of the EVA while maintaining a stress on the film; and
- (c) cooling the film to ambient temperature while maintaining a stress on the film during at least a portion of the step.

18. A process for manufacturing a heat shrinkable composite having improved antiblock properties which comprises

- (a) preparing a film of from 50 to 400 microns thickness from a thermoplastic elastomer resin composition comprising an elastomer, a thermoplastic polyolefin and a processing oil;

- (b) coextruding with said thermoplastic elastomer a layer of an ethylene polymer or copolymer of a composite, said polymer having a Melt Index of at least 3.0, and constituting from 15 wt % of the composite and having a thickness of less than 25 microns;
- (c) stretch orienting the composite at a temperature not less than 37°C and not greater than the crystalline melting point of the polymer by a draw ratio of from 1.5:1 and 2.5:1, the layer thickness is no greater than 15 microns and
- (d) cooling the stretched composite to a dimensionally stable elastomeric composite, the composite being heat shrinkable at temperatures above the cooling temperatures.

19. A composite comprising

- (a) a layer of flexible substantially inelastic material;
- (b) a layer of film as defined in any of claims 1 to 18 secured to the layer of flexible substantially inelastic material whereby application of heat connects both the film and the layer of flexible, substantially inelastic material.

20. A process for preparing an elasticized composite material which comprises

- (a) stretch orienting a film having a thickness of from 50 and 400 microns and a composition of
 - (i) from 15 to 30 weight percent of an EPM or EVA elastomer;

- (ii) from 60 to 80 weight percent of vinyl acetate copolymer (EVA) having acetate content of from 6 to 10 weight percent; and
- (iii) from 2 to 10 weight percent liquid hydrocarbon process oil; by drawing the film in the transverse direction from 1.5 to 9 times its original length at a temperature not less than 37°C and below the crystalline melting point of the film.

- (b) annealing the film at an annealing temperature of $\pm 11.1^{\circ}\text{C}$ of the orientation temperature while maintaining a stress on the film;
- (c) cooling the film to room temperature;
- (d) securing a strip of the film to a layer of flexible, substantially inelastic material at longitudinally spaced locations along the film to form a composite;
- (e) heating the composite to a temperature in excess of 37°C to within $\pm 11.1^{\circ}\text{C}$ of the orienting temperature whereby the film and the layer of flexible, substantially inelastic material contract to an elastic heat stable condition.

21. The process of claim 19 wherein the orienting temperature and annealing temperature are between 37°C and 71°C.

22. The film of claim 3 wherein the EVA has a VA content of from 15 and 35 wt %.

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